
SAMOS TO THE MOON:

The Clandestine Transfer of Reconnaissance Technology Between Federal Agencies

R. Cargill Hall

Among those who share a passing interest in the history of astronautics, two popular myths remain in vogue. The first contends that the U.S. Air Force, which began American work on reconnaissance satellites with the SAMOS Project, failed in the late 1950s in its efforts to create a near real time film imaging system. Second, and entirely dependent on the first axiom, the electro-optical imaging system developed later by the National Reconnaissance Office (NRO) represents the first application of near real time satellite imaging. The actual story, as you might suppose at this point, is rather different.

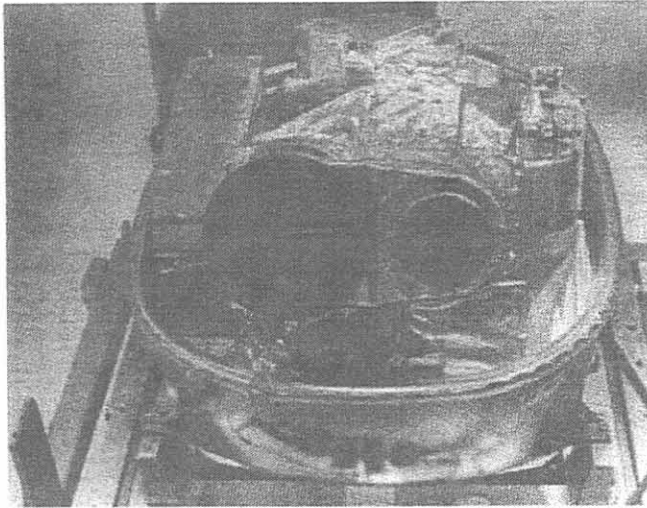
Conceived in the mid-1950s, the novel SAMOS imaging system at that time represented cutting edge technology—a near real time analog film-readout satellite. The Eastman Kodak Company



Photograph courtesy of EKC

SAMOS-Lunar Orbiter Camera Showing Film Track

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE OCT 2001		2. REPORT TYPE		3. DATES COVERED 00-00-2001 to 00-00-2001	
4. TITLE AND SUBTITLE SAMOS to the Moon: The Clandestine Transfer of Reconnaissance Technology Between Federal Agencies				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Reconnaissance Office,14675 Lee Road,Chantilly,VA,20151-1715				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 8	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Photograph courtesy of EKC

SAMOS-Lunar Orbiter Camera with Lenses Installed

then was scanned by a Columbia Broadcasting System flying spot line-scanner that consisted of a cathode-ray tube and a rotating anode having a high intensity spot of light. A photomultiplier converted the light passing from the scanner through the film into an electrical signal whose strength varied with the density of the emulsion layer of the film. The images were then radioed to Earth as frequency-modulated analog signals, to be assembled much in the manner of a wire photo, each image built up in swaths.

Judging SAMOS a national asset like the U-2, and one that ought not be directed by a military service, in late August 1960 President Dwight D. Eisenhower removed SAMOS from the control of the regular Air Force and assigned it to a new civilian office in the Department of Defense. A small contingent of Air Force officers and civilians responsible for SAMOS now reported to the director of the new office, Under Secretary of the Air Force Joseph V. Charyk. But, when launched into a low-Earth orbit in late 1960 and early 1961, SAMOS E-1 imaging payloads encountered problems—and not just the normal ones associated with electronic component or launch vehicle malfunctions. Like the CORONA Project that recovered film capsules, the E-1 readout payload also was a film-limited system and did not have a long life on orbit. Second, it had no image storage and recall capability, and had to transmit its take to a ground station on the next pass. Third, the images were not encoded; for security reasons that meant the film had to be read-out over the continental United States. Finally, SAMOS, operating at a

built the E-1 (preliminary) and E-2 (advanced) payloads. The E-1 featured a six-inch focal length lens in a camera that spooled a special two-component EKC Bimat (positive) film, and SO-243 (negative) film. The exposed negative film, converged with the gelatin-coated SO-111 Bimat film, was developed in a semi-dry chemical process, and

bandwidth threshold of six Megahertz and in view of a ground station for only a few minutes as it passed overhead, would lose part of its reconnaissance take on each revolution. In September 1961, therefore, Charyk, whose office recently had been recast as the NRO, terminated all SAMOS film read-out payloads. For satellite imagery in the near term, the NRO would concentrate its efforts on



Photograph courtesy of EKC

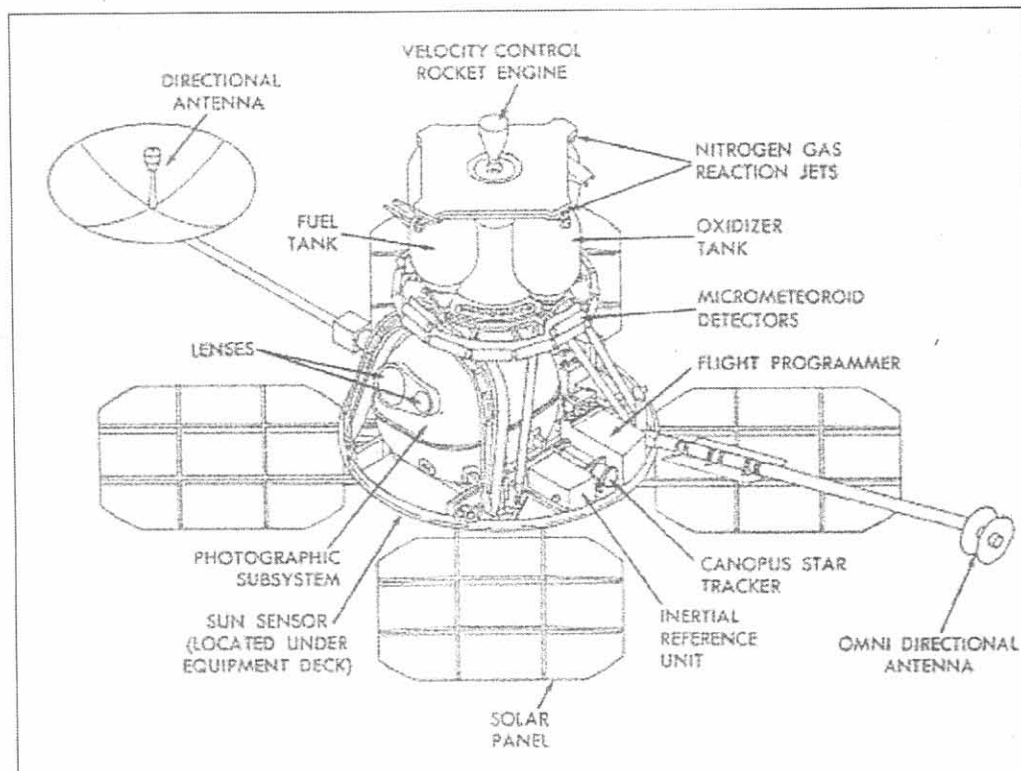
**SAMOS-Lunar Orbiter Camera Sealed in its Pressurized,
Temperature-Controlled Container**

CORONA and the other film recovery satellite systems then under development.

Having acquired, launched, and then terminated work on a near real time imaging satellite, however, NRO officials at that time agreed to consign the SAMOS imaging system to the National Aeronautics and Space Administration (NASA) for use in its deep space exploration program. The surreptitious transfer of this technology, a fact just recently declassified, has remained unknown to many in the NRO and NASA because of the compartmented security measures then in place. It occurred in the following manner.

When in the summer of 1963 NASA requested proposals for a five flight Lunar Orbiter imaging satellite, the Eastman Kodak Company asked for and received permission from the NRO to join The Boeing Airplane Company and bid on the program. In the effort to meet NASA requirements, Eastman would modify its E-1 camera with an 80mm focal length Schneider-Xenotar lens and an off-the-shelf 24-inch telephoto lens procured from Pacific Optical. The two lenses would be bore sighted at the surface of the moon for a planned orbit of about 30 miles altitude. Light would pass through each lens to the film, but the simultaneous images were interspersed with other exposures, and not placed side by side. The camera employed the existing velocity over height sensor to

regulate the speed of the focal plane shutter on the 24 inch lens and the between the lens shutter on the 80mm lens, which compensated for image motion. The Boeing Airplane Company, in turn, designed a solar-powered spacecraft stabilized in attitude on three axes that mounted other off-the-shelf hardware, and integrated it with the modified E-1 SAMOS payload.



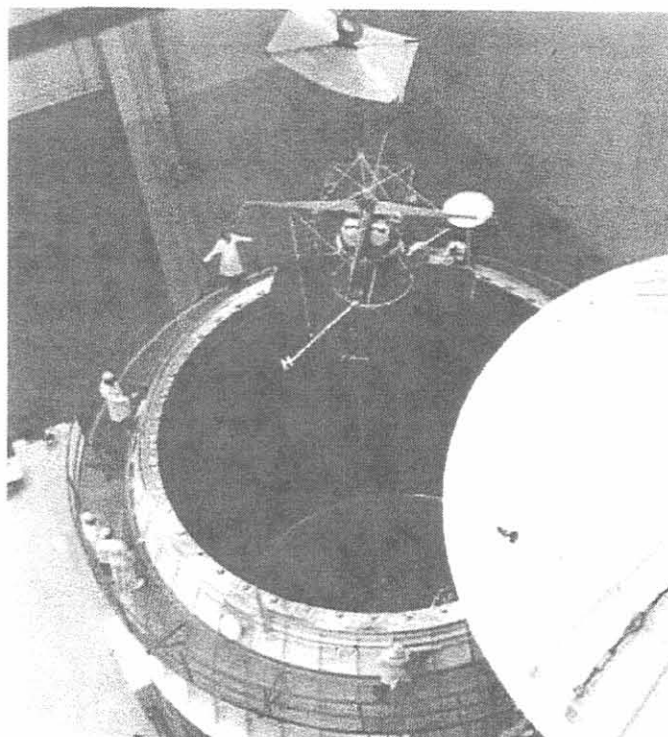
Photograph courtesy of The Boeing Company

Schematic of the 850-pound Boeing Spacecraft with Camera Installed

In the fall of 1963 a NASA Source Evaluation Board examined five proposals received from aerospace firms for the Lunar Orbiter, including the Boeing entrant. Board members found the other four proposals employed liquid film developing (difficult to contain in the hard vacuum of space), high speed film sensitive to solar radiation, and single lens camera designs that required development and testing to prove their operation in space. The Boeing/Eastman Kodak proposal featured a semi-dry film developing process, low speed film that required minimal shielding from solar radiation, and a twin lens camera along with much other equipment already developed and available. Although

the Boeing proposal carried the highest price tag, it clearly met or exceeded all of the requirements for the lunar mission, and the evaluation board selected it over the other competitors. On 20 December 1963 NASA Administrator James E. Webb announced selection of the Boeing proposal and, after Congress accepted the decision, an incentive contract was signed with the firm in April 1964.

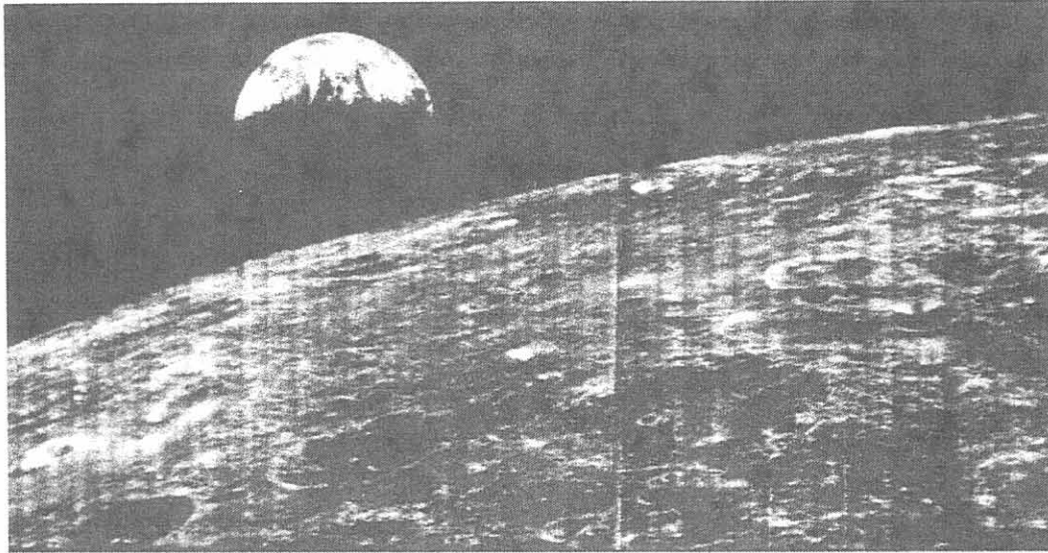
Whether members of NASA's source evaluation board knew of the Eastman Kodak camera's association with the classified National Reconnaissance Office is uncertain, but they surely became aware of its military origins as a component of the earlier Air Force satellite reconnaissance program. Whatever their understanding of its clandestine background in 1963, the mix of proven technology and extraordinary efforts of NASA and Boeing-Eastman personnel brought the space and ground segments quickly on line. The space agency launched five of the "SAMOS Lunar Orbiters" successfully between August 1966 and August 1967. Now equipped with film storage and in view of Earth receiving stations for over one-half hour on each revolution as it orbited our nearest celestial neighbor, the first three of the lunar orbiters completed the original task of obtaining detailed photographs needed to select Apollo landing sites. That left the last two film-readout near real time imaging satellites available to



Photograph courtesy of The Boeing Company

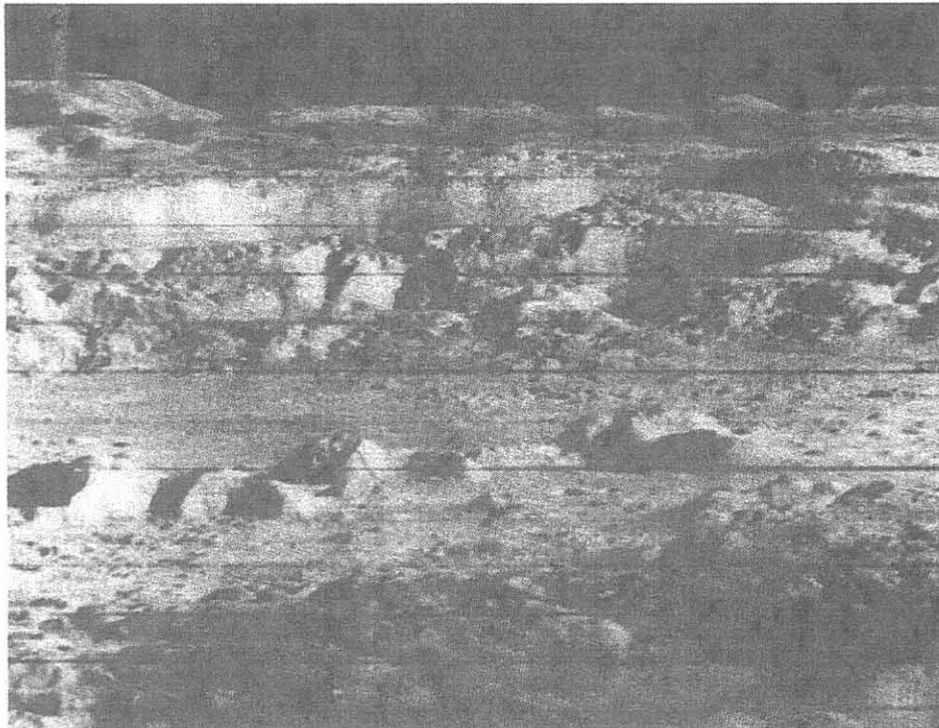
A Lunar Orbiter Prepared for Environmental Testing

photo-map virtually the entire moon and examine in detail various surface features. Collectively, these images of the Earth's natural satellite proved a selenographic bonanza that paved the way for Project Apollo's manned lunar landings later in the decade.



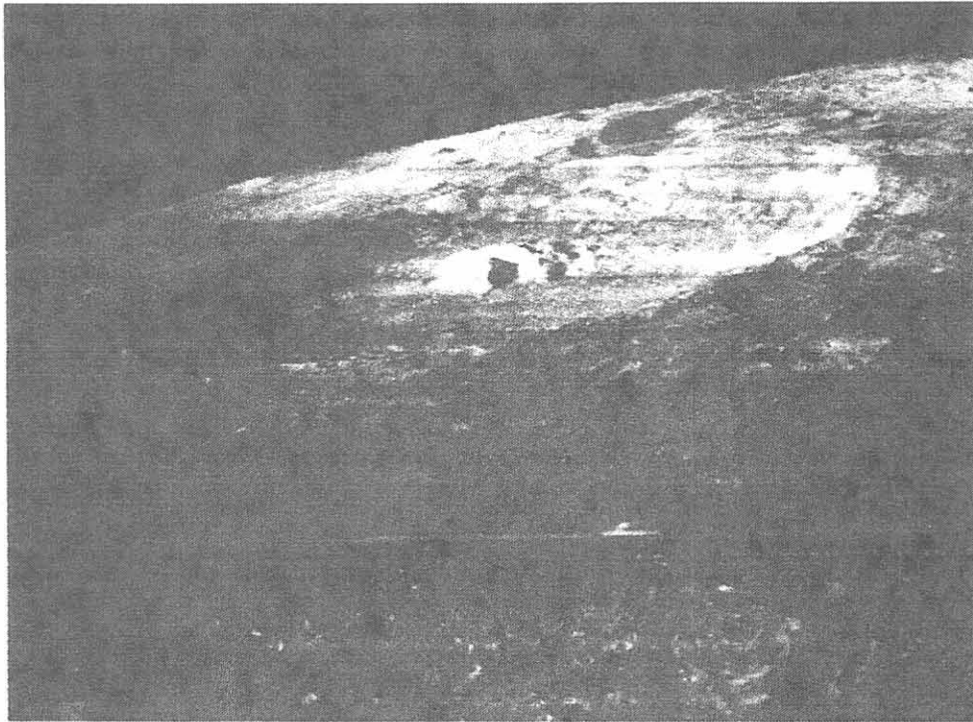
NASA Photograph

First Picture of the Earth from the Moon taken by Lunar Orbiter I, 23 August 1966



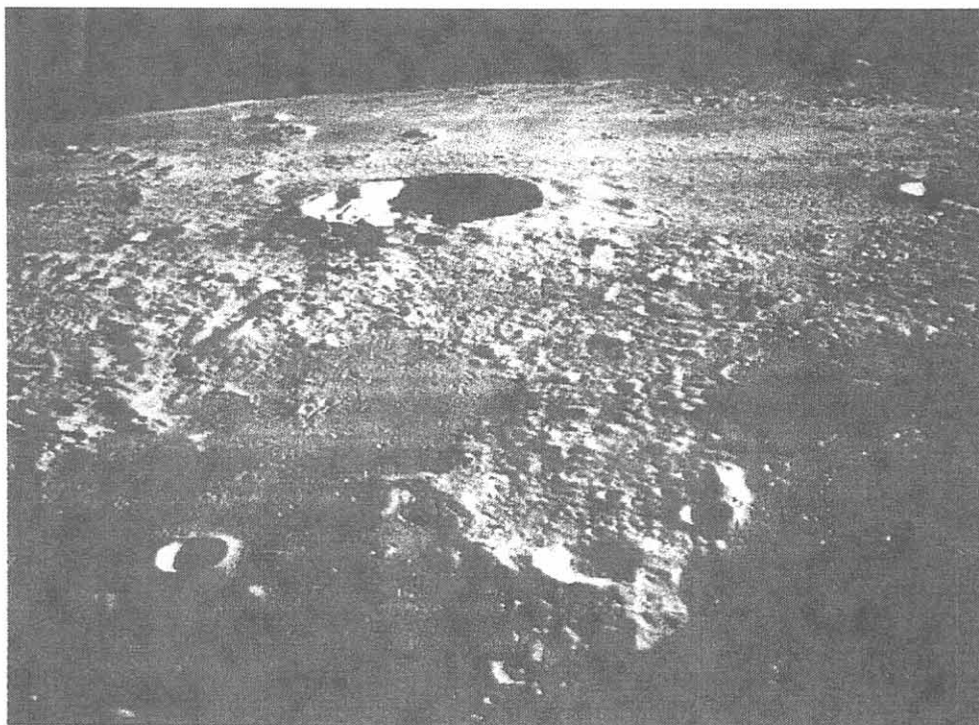
NASA Photograph

Oblique View of Crater Copernicus Viewed from Lunar Orbiter II,
28 November 1966



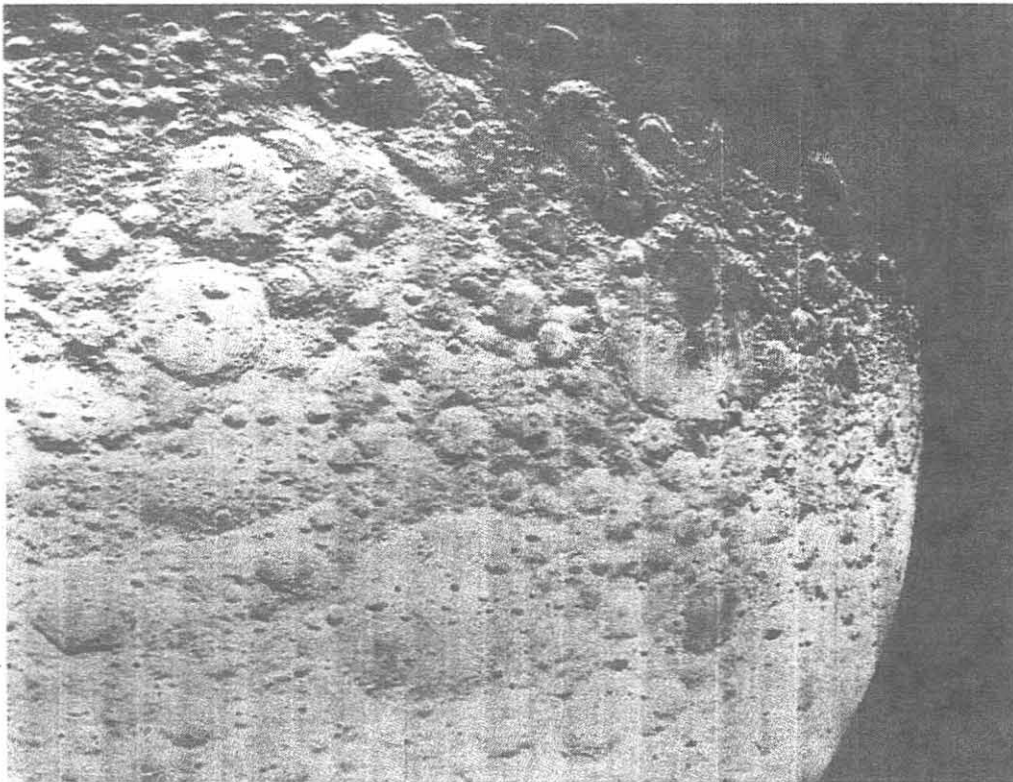
NASA Photograph

Oblique View of Crater Theophilus Viewed from Lunar Orbiter III, 17 February 1967



NASA Photograph

Oblique View of Crater Kepler Viewed from Lunar Orbiter III, 20 February 1967



NASA Photograph

Southern Hemisphere of the Moon's Hidden Side as Viewed from Lunar Orbiter II at an altitude of 900 miles, 20 November 1966

Instead of representing an abject failure, SAMOS secretly helped make possible manned lunar exploration *and* it became the nation's first near real time film imaging system in space. The NRO's electro-optical imaging system that followed in the 1970s was, to be sure, the wave of the future; it became the first near real time digital imaging system. But, as near real time myths go, it ran second to an earlier NRO contribution to deep space exploration.

Office of the Historian
National Reconnaissance Office
October 2001